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THE
WHITE-MARKED TUSSOCK MOTH
AND ITS CONTROL

ON

SHADE TREES AND ORCHARD TREES

BY

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WE SHALL BE PLEASED to hear from any one concerning damage or trouble of any kind due to insect pests. No postage is required on such letters of inquiry when addressed:

DOMINION ENTOMOLOGIST,

Department of Agriculture,

OTTAWA, ONT.

Such inquiries should be accompanied in all cases where it is possible by specimens of the insects. The insects should be sent packed with their food plant in a strong wooden or tin box to prevent loss in transit. Packages up to 12 ounces in weight may be mailed free and every package should bear or contain the sender's name and address and be accompanied by a letter.

DEPARTMENT OF AGRICULTURE,

OTTAWA, January 15, 1918.

The Honourable,
The Minister of Agriculture,
Ottawa

SIR,—I have the honour to submit for your approval, Entomological Circular No. 11, entitled "The White-marked Tussock Moth," which has been prepared under my direction by Mr. J. M. Swaine, Assistant Entomologist in charge of Forest Insect Investigations, and Mr. G. E. Sanders, Field Officer.

The White-marked Tussock Moth is one of our native insects which is widespread throughout Eastern Canada, and periodically it increases to so great an extent as to cause serious damage to the shade trees in and around our cities and towns, and to fruit in the orchards. An outbreak of this insect is now taking place in Ontario and the Maritime Provinces, and as usual it is causing serious apprehension in many places, with the result that we are receiving many requests for information concerning control measures. This circular has been prepared to meet these calls for assistance, and not only to furnish information required by the public but also to impress upon civic authorities the importance of taking steps to prevent the destruction of their valuable shade trees by this and other insects which assist in the destruction of a feature which adds so much to the beauty and comfort of our Canadian towns and cities.

I have the honour to be, sir,

Your obedient servant,

C. GORDON HEWITT,
Dominion Entomologist.



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THE WHITE-MARKED TUSOCK.—1, an egg-mass attached to a cocoon; 2, a caterpillar feeding upon a leaf; 3, the female moth and a freshly deposited egg-mass; 4, the male moth. Figs. 1, 2, and 3 are from Bul. 312, Geneva Agric. Exp. Station.

The White-Marked Tussock Moth

(*Hemerocampa leucostigma* S. & A.)

By J. M. SWAINE, In charge of Forest Insect Investigations, Entomological Branch, Department of Agriculture, Ottawa, Ont.

The well-known tufted caterpillars of the White-marked Tussock Moth have been recognized for many years as among the worst enemies of deciduous shade trees in our eastern towns and cities. The species is a native of North America, and it is found on deciduous trees nearly everywhere each season in varying numbers. Periodically these caterpillars become so extremely numerous, especially about our cities and towns, that large numbers of our finest shade trees are stripped by them, and seriously weakened in addition to being completely disfigured by the defoliation.

The last outbreak in Eastern Canada occurred between the years 1903 and 1911, extending from Nova Scotia to western Ontario, but affecting the towns near the Great Lakes, the St. Lawrence river, and the sea coast more seriously than the others. Ottawa, for instance, has apparently no record of a serious outbreak, and egg-masses are as rare this year as usual. This very serious outbreak was finally and very suddenly brought under control by insect parasites in the summer of 1911, and since that time the White-marked Tussock caterpillars have been present usually in comparatively small numbers. Last season, however, the species had become very abundant in several towns and cities, and the numerous egg-masses now on the tree trunks indicate a severe outbreak next summer in several places, including Moncton, Montreal, and Toronto. This species is notably a pest of cities and towns, but is injurious everywhere in times of abundance. It is an important enemy of apple trees, since in addition to defoliating the trees, the caterpillars feed upon and destroy the young fruit. Vigorous and properly conducted control work during the coming winter and spring will prevent the greater part of the threatened injury.

DESCRIPTIONS OF THE INSECT.

The Adult.—The two sexes of the adult stage are strikingly different in appearance. The *male* is a beautiful greyish moth, about an inch and a half across the wings when spread, with tufted legs, feathered antennæ, and transverse wavy lines across the fore wings.

The *female*, on the other hand, is a very stout and clumsy creature, greyish in colour, almost without markings, and nearly wingless. She usually crawls upon the cocoon from which she has emerged, and after pairing deposits there her mass of eggs, and dies.

The Eggs.—The eggs are deposited in masses containing from one hundred to five or six hundred; one egg-mass is laid by each female, usually upon an empty cocoon. The mass of eggs is covered by a thick layer of white frothy fluid which hardens rapidly, and, in addition to holding the eggs together, protects them from adverse weather conditions, and in some measure probably from their enemies. The individual eggs are small, whitish, and nearly spherical. The egg-masses of the closely related Rusty Tussock Moth are laid bare upon the cocoon, without the frothy covering, and are thus easily distinguished from those of the White-marked Tussock.

The Caterpillar.—The caterpillar of this species is perhaps as well known as any other among our shade-tree insects, owing both to its remarkable abundance during the outbreaks, and to the striking beauty of its colours and vestiture. The length, when full-grown, is slightly more than an inch. The

colours are in longitudinal bands, more strongly marked behind, yellow below, greyish on the sides, with a bright yellow, subdorsal band above on each side of a median black band. The median dorsal line bears four prominent white or yellowish brushes of hair, one on each of the first four abdominal segments, and a small coral red tubercle on each of the sixth and seventh segments. The head and the upper part of the first thoracic segment are bright coral red. Two long black pencils of plumed hairs project from the sides of the first thoracic segment over the head, and a similar pencil upwards and backwards from the median line of the eighth abdominal segment, the twelfth including the head. The body is sparsely clothed with long, greyish hairs arising in radiating tufts from yellowish tubercles.

The Rusty Tussock Caterpillar differs in being less brightly coloured and in having a pencil of long black hairs on each side of the fourth segment behind the head.

The Pupa.—The adult caterpillars spin greyish silken cocoons, attached usually to the bark of tree trunks. Within the cocoon the caterpillar changes its skin and appears as the chrysalis. The male chrysalis is brown or nearly black, and sparsely clothed with greyish hairs; that of the female is much larger, without the distinct wing cases, and has a transverse patch of light-coloured scales across the back of each of the first three segments behind the head. The cocoon of the female is tougher and darker in colour than that of the male.

THE LIFE-HISTORY AND HABITS.

The winter is passed in the egg-stage in the white conspicuous egg-masses, attached usually to the cocoons. Normally the egg-masses are deposited upon the trunk and the under side of the larger branches, but in seasons of great abundance they occur in considerable numbers in the upper parts of the trees and upon nearby objects, such as fences and buildings.

The eggs hatch usually during the month of June. In very early seasons in the district about Montreal, some egg-masses hatch in the last week of May, and the greatest activity in hatching is in the first half of June; in late seasons the greatest activity in hatching is in the last half of June, and many egg-masses remain unhatched until early in July. In Nova Scotia the eggs hatch, usually, during the last week of June. The species, therefore, remains in the egg-stage for practically ten months, from about the end of July until the following June, and a long period is offered for control by the removal of the egg-masses.

The young caterpillars spread somewhat over the foliage, and feed individually on the under surface of the leaves, dropping by means of a thread of silk when disturbed. As they increase in size the wandering habit becomes more marked, and they devour the greater part of the leaf, seriously or completely defoliating the trees when their numbers are great. They complete their growth in from four to six weeks. Many of the large caterpillars wander about freely from tree to tree, so that trees which have been previously clean may become very badly infested by them. The older caterpillars are thus distributed locally by these wandering habits. It is probable that the small caterpillars, when suspended on the silken thread, may be carried considerable distances by winds, and the infestation still further extended in this way. When the caterpillar becomes full grown, during July or early in August, it comes to rest, normally upon the trunk or larger branches, but during an outbreak, upon any part of the tree or upon neighbouring objects. Here it spins a greyish cocoon composed of silk and hairs from the body firmly attached to the bark or to the object upon which it rests, and within this it changes to the chrysalis or pupa. About ten days or two weeks are passed in this condition, and then the adult moth appears from the cocoon. The wingless female seldom moves away from the cocoon out of which she has emerged; usually she crawls upon it, and after being fertilized by a male and depositing there her whitish egg-mass, dies and

usually falls to the ground. The male caterpillars cease feeding and spin their cocoons earlier than the females, and produce distinctly smaller chrysalids.

There is only one brood annually in Eastern Canada, except that a partial second brood apparently occurs in southern Ontario in favourable seasons.

THE INJURY.

The extensive defoliation by the caterpillars destroys the beauty of the trees for much of the season, and often injures them so seriously that branches either die outright after repeated attack, or become so weakened thereby that they gradually succumb to injury by other insects such as borers, and fungi.

The list of trees attacked by the White-marked Tussock includes a large number of our deciduous shade trees, and even a few conifers. In Eastern Canada the favourite food trees appear to be willow, birch, horse-chestnut, basswood, elms, maples, poplars, and fruit trees. Dr. Felt has listed the following host-tree records from the Eastern United States: "linden, horse-chestnut, buckeye, maple (specially the soft and Norway), boxelder, honey locust, apricot, garden plum, wild plum, garden cherry, chokecherry, rose, pear, apple, quince, ash, elm (several species), sycamore or buttonwood, butternut, black walnut, hickory, oak, birch, alder, willow, poplar, spruce, fir, larch, and cypress.

NATURAL ENEMIES.

This species has a very large number of natural enemies. Minute hymenopterous parasites breed within and destroy the eggs, a large number of hymenopterous and dipterous parasites kill the caterpillars and pupæ, and various predaceous insects also aid in reducing their numbers. Certain fungi and bacteria, which spread rapidly in epidemics, destroy great numbers of the caterpillars, and are sometimes a chief agent in their control.

The last outbreak of the White-marked Tussock in Eastern Canada, as already mentioned, extended from Halifax to western Ontario, and lasted, in all, from 1903 to 1911. It was not anywhere abundant throughout the whole period, however, and was brought finally and suddenly to a close by the action of parasites and fungi. The species has bred in obscurity since that time, and is just now coming again to prominence, since the scarcity of its parasites has allowed it to breed to such great numbers. Eventually they will again effect its control, in time probably to save the life of the trees, but not soon enough to prevent much injury in addition to the disfiguration of the trees during the summer.

A few of our native birds feed upon hairy caterpillars such as the White-marked Tussock, and are important factors in natural control in sections where they are still numerous. Unfortunately, man and the English sparrow have united to drive these useful birds away from the neighbourhood of our cities, towns, and larger villages, with the result that the White-marked Tussock and other destructive insects find our centres of population more acceptable to them than the open country. The protection and encouragement of our insectivorous birds is a most important method of insect control.

CONTROL MEASURES.

The life of city shade-trees is sufficiently precarious at the best of times. The almost impossible soil conditions, and the extremely adverse atmosphere content of smoke, dust, and gasses are very serious obstacles to healthy tree growth; and the yearly attacks by ice storms, boring insects, defoliating insects, and fungi make the life of a city-grown tree one long, or short, series of adventures.

The great value of shade trees to cities and towns is everywhere recognized, and there should be no hesitation in making a reasonable expenditure to protect them from those enemies which may be successfully controlled.

One of the most important methods of preventing serious insect injuries is found in the provision of the best possible conditions for tree development. Proper surgical treatment to remove rot infections and fill the resulting cavities, and to support the weakened parts with cement, iron bolts and chains, so as to prevent breakage, as well as the provision of abundant water in dry seasons, and general precautions against injurious insects, help the trees to a vigorous condition that withstands more successfully the severe periodical insect outbreaks.

The life-history of the White-marked Tussock discloses two periods, the egg and the larval stages, during which control measures may be successfully applied. The eggs may be destroyed, and the caterpillars may be killed by poison.

THE DESTRUCTION OF EGG-MASSSES.

The more effective and economical method for application in cities and towns is usually considered to be the destruction of egg-masses during the dormant season, combined with banding the tree trunks. Fortunately the white masses are so conspicuous that they are at least easily observed. The species is present in the egg-stage for practically ten months of the year, in this climate, and a long period is thus offered for the removal of the egg-masses.

If the eggs are entirely removed from a group of trees during the fall, winter, and spring, and the trunks are properly banded to prevent reinfestation by wandering caterpillars, the foliage will be completely protected from tussock caterpillars for the season.

The egg-masses are either killed by painting them with creosote, or removed by means of wire brushes or scrapers.

Painting with Creosote.—In the control of the Gipsy Moth, the egg-masses are killed by painting them with creosote by means of a brush. This method has also been employed successfully against the Tussock Moth egg-masses, and in some cities has replaced entirely the use of the scraper and wire brush, being considered more effective and very much cheaper. Rubber-set paint brushes are used, attached to light pine poles, about 16 feet long and 1½ inches square. The creosote is darkened with lampblack so that the painted egg-masses can be more easily distinguished.

The Egg-mass Remover.—A special wire brush, 5 inches long and 1 inch wide, has proven most efficient in removing the egg-masses. A narrow hoe-blade, 6 inches long and 2 inches wide, has also been used effectively. The brush or hoe blade is attached to a long handle; two lengths may be employed, one of 10 feet and the other of 20 feet.

The work of removing or destroying the egg-masses is done usually by gangs of three men each, equipped with a 40-foot extension ladder, and either egg-mass removers and canvas sheets or creosote outfits, one man directing the work from the ground.

When the egg-masses are removed by brush or scraper, some of them are broken and the eggs are scattered about the ground. Many of these eggs would probably survive and reinfest the trees; and it is therefore advisable to spread large canvas sheets on the ground beneath the trees before the operation so that the eggs may be easily collected, or else to have all the trees properly banded before the hatching time of the eggs in the following season.

In collecting the egg-masses, care should be taken not to remove the cocoons which do not bear the eggs. These cocoons contain useful parasites, and they should be preserved; they are easily distinguished from the true egg-masses by their darker colour. The egg-masses themselves will probably contain a certain number of minute egg parasites, which would be destroyed by burning the eggs. In order to utilize the services of these beneficial insects, in seasons when egg-parasites are abundant, the egg-masses may be stored until spring, and then distributed in small, specially protected wooden boxes near the infested trees; the boxes

should have a complete band of raupenleim or tanglefoot on the inner face of the sides near the top, so as to prevent the escape of the young caterpillars, and should be covered with wire netting. The boxes should be removed after the parasites have emerged.

SPRAYING WITH ARSENATES.

When the egg-masses have not been removed from the trees, and the caterpillars are numerous upon the foliage, it is possible to prevent further injury by spraying the trees with lead arsenate paste at the rate of 5 to 15 pounds to 100 gallons of water. Lead arsenate is better for this purpose than Paris green, since it can be used in stronger solutions without danger of serious injury to the foliage, and it adheres to the leaves for a much longer time. Five pounds of lead in one hundred gallons of water will kill the caterpillars at the time of hatching, 10 pounds of poison should be used if the caterpillars are more than a few days old, and 15 pounds after they are one-third grown.¹

The first application should be made, if possible, just before the eggs hatch, or at least as soon as the caterpillars appear; the sooner they are killed the less the injury will be, and also the caterpillars are much less readily killed by poisons after they become one-third grown, or even after a few days' feeding. Their first meal should carry the poison. See also page ...

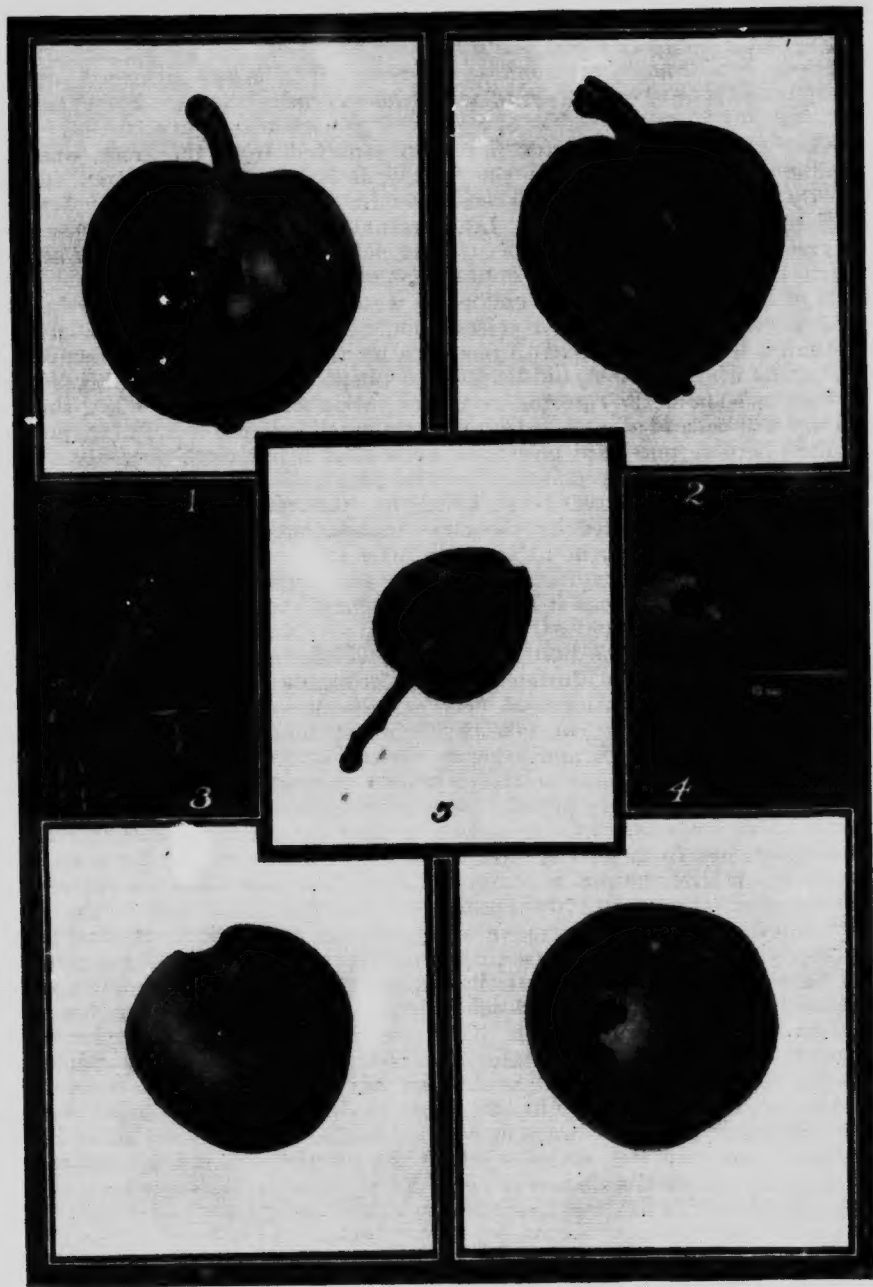
After caterpillars have been killed by the use of poison, the trees may again become infested by the older wandering caterpillars from nearby foliage. While these may actually cause little injury to the foliage, they will spin their cocoons on the trunks and branches and infest the trees for the following season. For this reason it is necessary to band the trunks before the caterpillars begin to migrate.

As a rule it would be better to depend chiefly upon the destruction or removal of the egg-masses, during the dormant season, for control in cities and towns in moderate infestations. A very heavily infested tree is often seriously defoliated before the spray can take effect, unless the poison is upon the leaves when the caterpillars hatch and begin to feed. The discoloration of the foliage and the houses by the spray mixtures is also an undesirable feature. When, however, the trees are very heavily laden with egg-masses, such as occurs this winter in some Ontario towns, it will be at least extremely difficult to remove all the egg-masses from all the most heavily infested trees. Under such conditions it is felt that the proper method of procedure is to clean the egg-masses completely from the less heavily infested sections of the city, and in the most heavily infested portions to remove all egg-masses from the trunks and larger branches, but without attempting to remove all from the tops. Arrangements would be made to spray these partially cleaned trees with lead arsenate as soon as the caterpillars appear or, preferably, immediately before the eggs hatch, as well as any others which require it. The trees should all be banded with raupenleim or tanglefoot to prevent infestation from egg-masses on neighbouring fences and the buildings, if such are close at hand. Every city with many valuable shade trees to protect should own a suitable power-spraying outfit. With a proper equipment it would always be possible to check outbreaks of either biting or sucking insects on the foliage. The White-marked Tussock is only one of many injurious shade-trees insects.

BANDING THE TREES.

It has already been pointed out that after the egg-masses or the caterpillars have been destroyed the trunks of the trees should be banded so as to prevent reinfestation by wandering caterpillars. If there is any danger of infestation

¹This rate is for application to shade trees; for use on fruit trees see page 12. The powdered form of lead arsenate is used at one-half these strengths.



Types of injury to apples by the White-marked Tussock caterpillars. Fig. 5 shows the caterpillar at work.—Original.

from hatching eggs on the ground or on objects near the trees the bands should be applied before the eggs hatch, and at the latest they should be in place before the migration time of the caterpillars. The date of hatching varies so widely with the weather conditions of the season that no definite date can be recommended, but the bands should usually be in place by the middle of June, and in some seasons before that time.

Tree Tanglefoot.—Several devices for preventing the caterpillars climbing the trees, such as bands of cotton, burlap, metal, and various sticky substances, have gradually given place to the sticky mixture known as "Tree Tanglefoot," which may be obtained in bulk from any dealer in insecticides. A fair substitute may be made by boiling together equal parts of castor oil and resin.

The tanglefoot is applied with a wooden paddle so as to form a complete ring about the trunk, 4 inches wide, from 5 to 8 feet from the ground. Before the mixture is applied the surface of the trunk on which the application is to be made should be scraped unless the bark is already sufficiently smooth. The tanglefoot gradually hardens on the surface, and it is therefore advisable to break its surface by scraping it over with a coarse comb at intervals of ten days or two weeks. Instead of applying the tanglefoot to the bark it may be spread upon a strip of canvas or burlap fastened around the trunk.

When the material known as *raupenleim* is available, it makes the most effective band; it is more easily applied, and remains sticky for a much longer time.

While the trees are being banded, any connections with infested locations should be broken. Telegraph wires or branches interlocking with infested trees may reinfest the clean trees after all ordinary precautions have been taken; and it is therefore necessary to band telegraph and telephone poles whose wires have any connection with the shade trees to be protected, or to cut out with trimmers the branches which connect with the sources of infestation.

Spraying Outfit.—For spraying city shade trees effectively it is absolutely necessary to have an efficient spraying outfit. A power sprayer is required, capable of giving from 400 to 600 pounds pressure, and with a pump capacity great enough so that a solid stream may be held constantly from 65 to 85 feet up from the nozzle. These requirements should be insisted upon when purchasing spraying outfits for shade-tree work.

THE WHITE-MARKED TUSSOCK MOTH AS AN ORCHARD PEST.

By G. E. SANDERS.

At intervals of from ten to seven years, most orchards in Canada are visited by the Tussock Moth. From one week to ten days after the blossoms fall the young larvæ emerge from the egg and begin to feed on the leaves. After feeding for two weeks on the leaves the jaws become strong enough so that they can attack the fruit. From that time until they pupate, or from early July until mid-August, the larvæ feed on the fruit rather than on the leaves of the apple. In 1907, 1911, and 1916-17 the Tussock Moth was the most serious pest in many of the orchards of the Maritime Provinces, damaging, in some cases, as high as 50 per cent of the fruit. The injury to the fruit is somewhat similar to that inflicted by the Fruit Worms, but instead of a round deep bite into the fruit, the injury by Tussock caterpillars usually takes the form of long, narrow, shallow, irregular channels, which do not heal over as smoothly as Fruit Worm injury, but rather with a thick, brown, corky scab.

The larvæ of the White-marked Tussock emerge just before the time of the fourth, or last, summer spray, and in the past the last summer spray has been recommended as the proper spray to control it. In the spraying work of 1917 it was found that from forty-four trees receiving the first spray only, 9.1

per cent of the fruit showed Tussock injury. Forty-four trees receiving the second or pre-blossom spray only, 6.5 per cent of the fruit showed Tussock injury. Forty-four trees receiving the third or after-blossom spray only, 4.9 per cent of the fruit showed Tussock injury. Forty-four trees receiving the fourth spray only, 11.8 per cent of the fruit showed Tussock injury.

These figures show how necessary it is to have the spray on the leaves before the emergence of the larvæ of biting insects from the egg, in order to get the best control, and that the residue of a spray applied two weeks before the emergence of the larvæ is of more value in control by poisoning the larvæ when they eat their first meal than a spray applied at full strength two days after the larvæ emerge.

For the control of outbreaks of Tussock Moth in orchards, we would recommend for the spray immediately after the blossoms, or the Codlin Moth spray, either of the following:—

First Choice.—Standard paste lead arsenate 12 to 15 pounds to 100 gallons of water, and no fungicide; the lead arsenate at this strength is an efficient fungicide.

Second Choice.—Sodium sulphide (soluble sulphur 3 to 3½ pounds, Sulfolicide 2-2½ quarts, Spra sulphur 3 pounds; arsenate of lime, 1½ pounds (in serious outbreaks 1½ to 2 pounds); hydrated or water-slaked lime, 20 to 25 pounds; water, 100 gallons.

Third Choice.—Lime-sulphur 1.006 sp. gr. or two gallons commercial concentrate to 100 gallons water. Arsenate of lime 1½ pounds (and in serious outbreaks, 2 pounds), to 100 gallons. (In applying lime-sulphur for the third spray, do not wet the under side of the leaves, apply the spray to the upper side).